UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

Charged Particle Distributions from Inclusive DIS events

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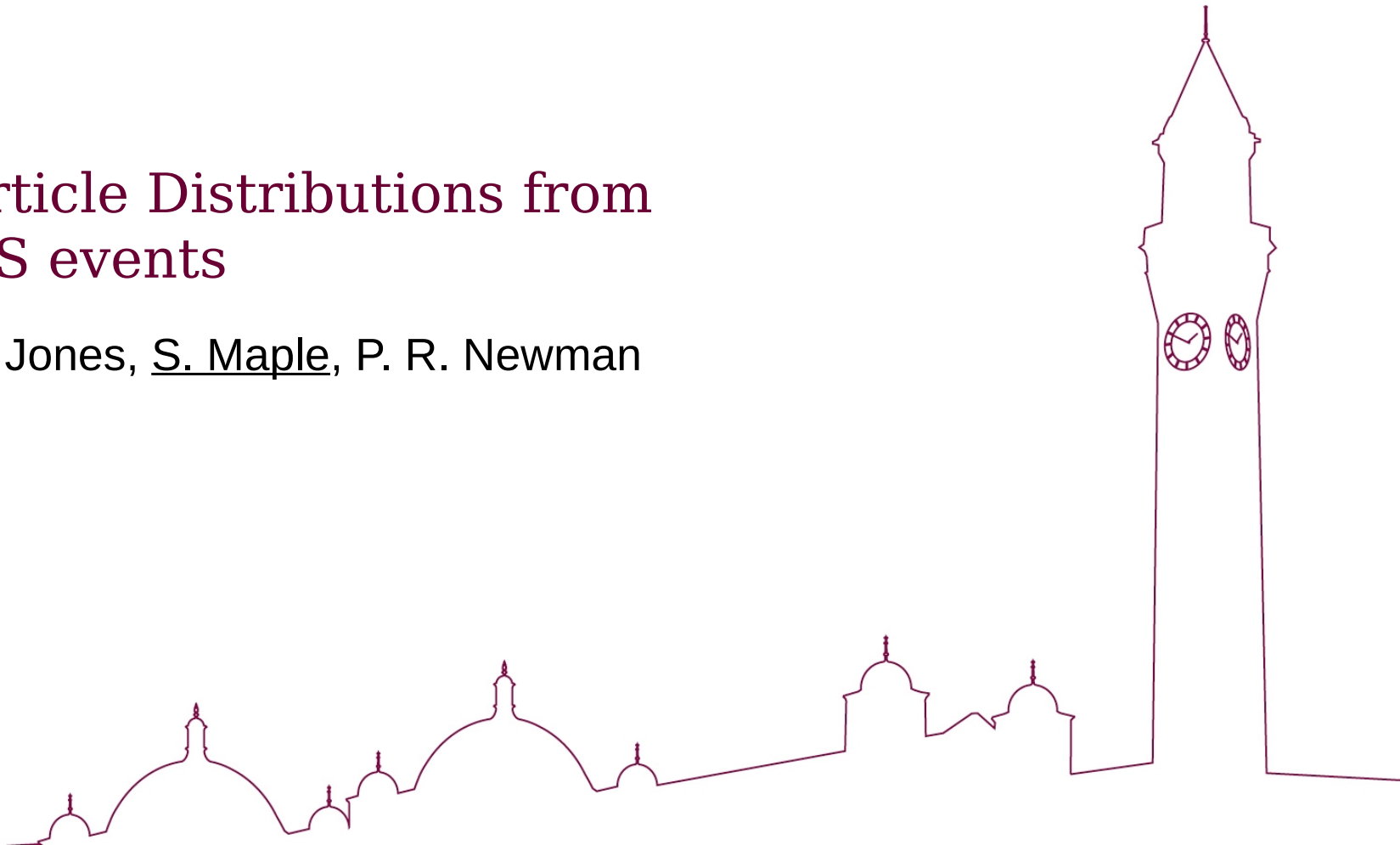
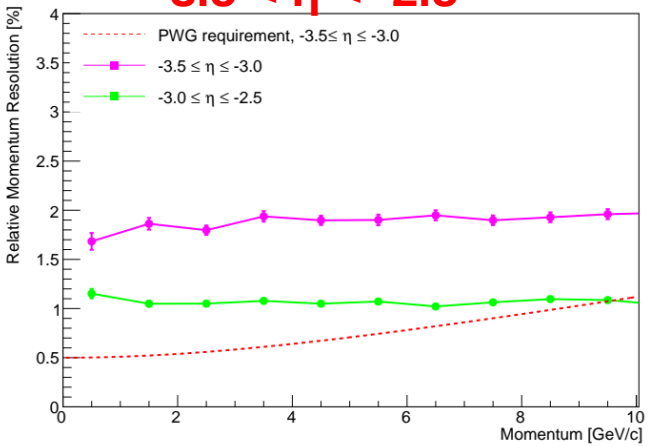


Overview

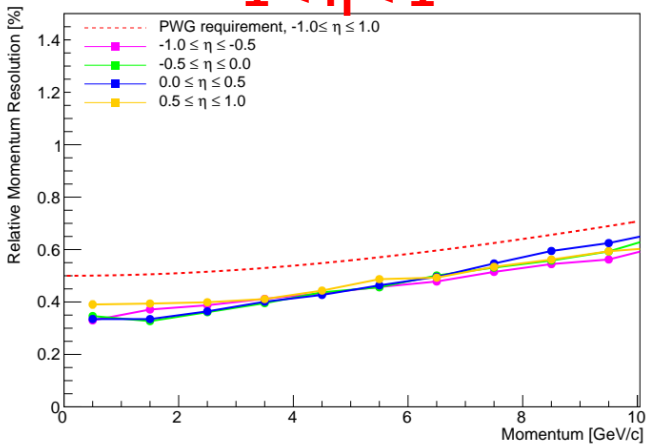
- Recap of Baseline 2.0 performance (Fun4All)
  - These results are in agreement with the ones from the ATHENA software that can be found in the proposal supplementary material TWIKI
- Neutral Current DIS events generated with Pythia8
- Charged particles reconstructed by Baseline 2.0 tracker (Canyonlands, ATHENA Software)
  - Total number of electrons/charged pions plotted in p-η bins for NC-DIS events

Relative Momentum Resolution (Baseline 2.0)

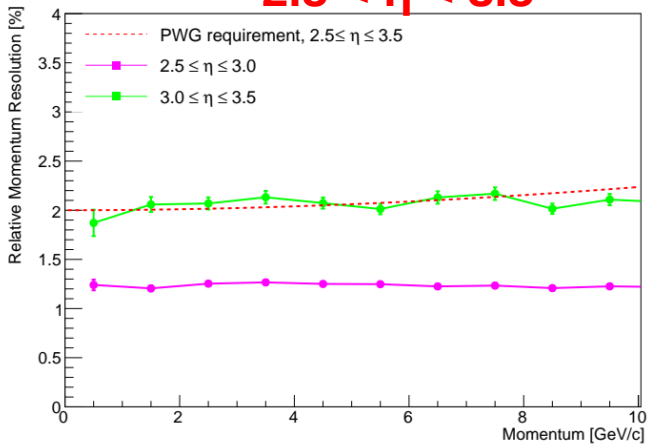
-3.5 < η < -2.5



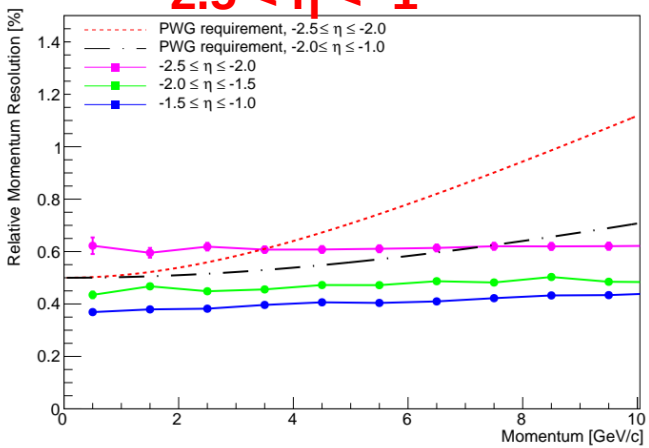
-1 < η < 1



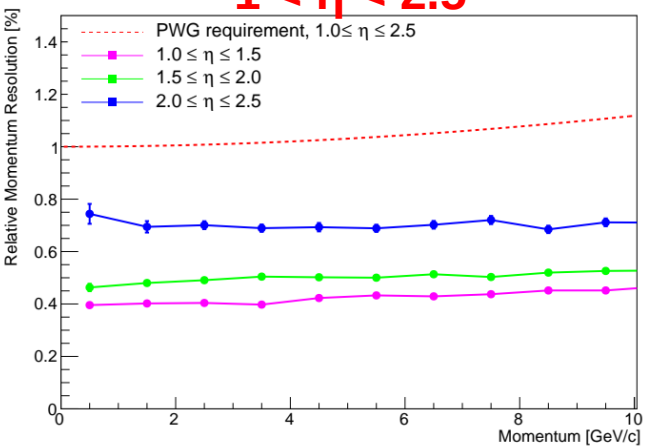
2.5 < η < 3.5



-2.5 < η < -1



1 < η < 2.5

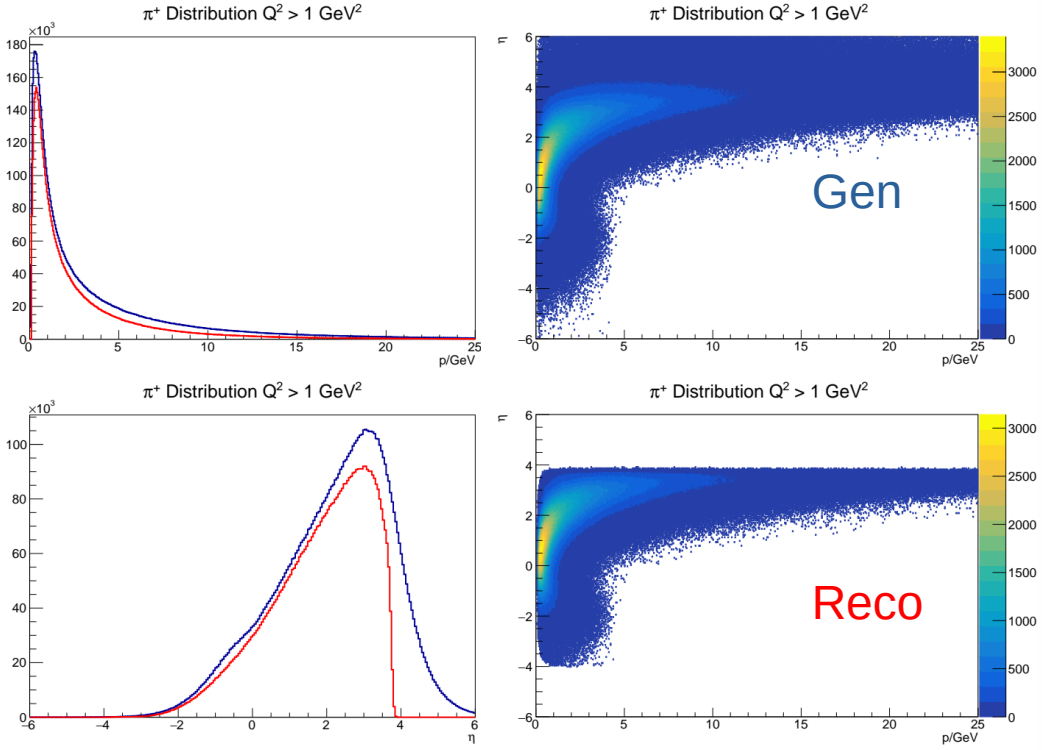


→ PWG requirements met for central and forward region

→ for η < -2 the requirements are no longer met for lower momenta

Pion distributions (5x41GeV^2)

Pythia8 NC-DIS events, Q^2>1GeV^2
Files at ATHENA/RECO/canyonlands-v1.2/DIS/NC/5x41/minQ2=1 on S3



- Particles generated in Pythia8 and passed through Full Simulation (DD4hep) and reconstructed with Juggler algorithms
- Right hand plots show total number of positive pions generated/reconstructed in a given η-p bin
- Left hand plots are the projections in η (bottom) and momentum (top)
- For 5x41GeV^2 most charged pions from NC-DIS events have momentum of less than 10GeV

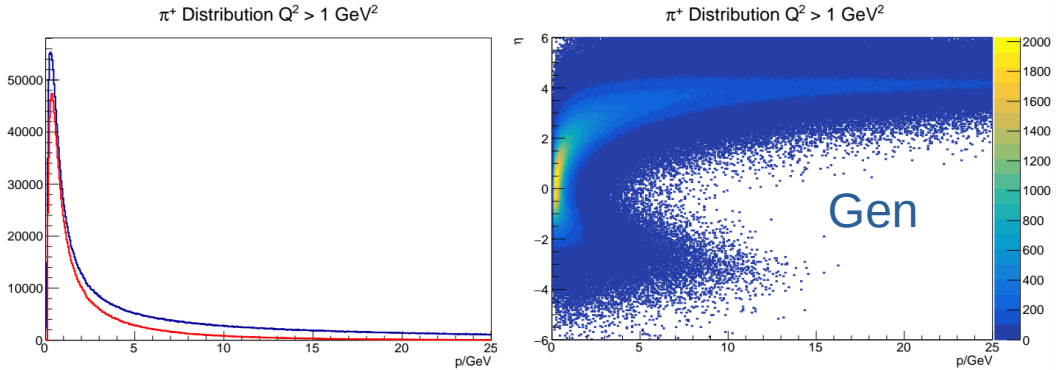
Number of reconstructed pions

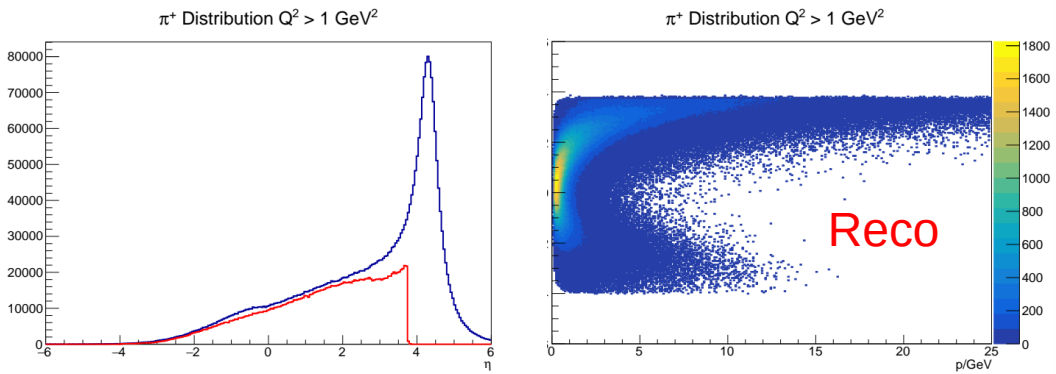
Number of generated pions

Most pions generated at η > -2:
→ Requirements met

Pion distributions (18x275GeV^2)

Pythia8 NC-DIS events, Q^2>1GeV^2
Files at ATHENA/RECO/canyonlands-v1.2/DIS/NC/18x275/minQ2=1 on S3





- Same procedure as for 5x41GeV^2
- Right hand plots show total number of positive pions generated/reconstructed in a given η-p bin
- Left hand plots are the projections in η (bottom) and momentum (top)

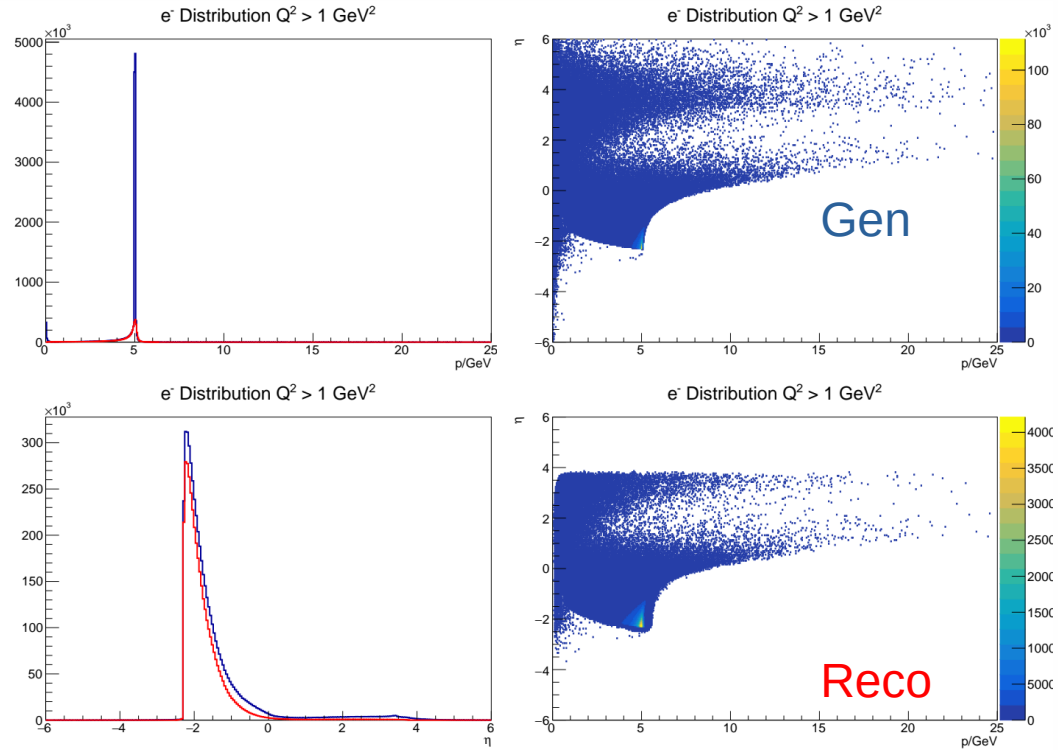
Most pions generated at η > -2 and with p < 10GeV:
→ Requirements met

Number of reconstructed pions

Number of generated pions

Electron distributions (5x41GeV^2)

Pythia8 NC-DIS events, Q^2>1GeV^2
Files at ATHENA/RECO/canyonlands-v1.2/DIS/NC/energy/minQ2=1 on S3



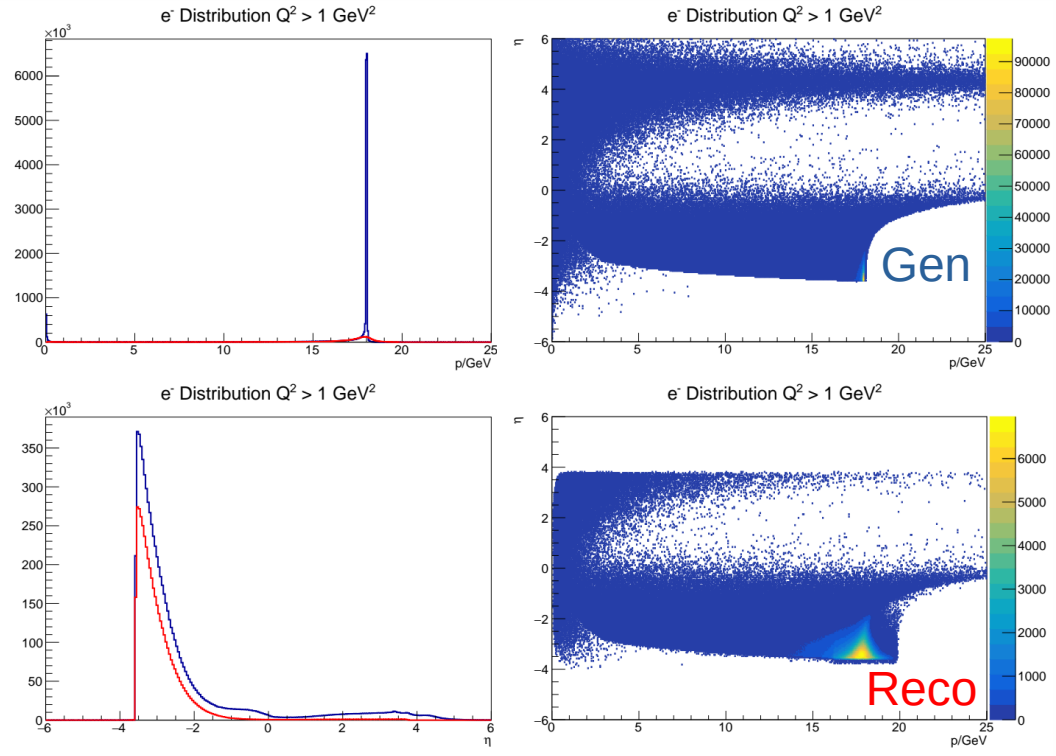
- Electron distribution strongly peaked in η and momentum
- For 5x41GeV^2 this is at 5GeV in momentum and η~-2.3
- At a momentum of 5GeV the requirements are met for η > -2.5
  → Tracker can adequately measure scattered electrons down to Q^2=1GeV^2 for this beam configuration

Number of reconstructed electrons

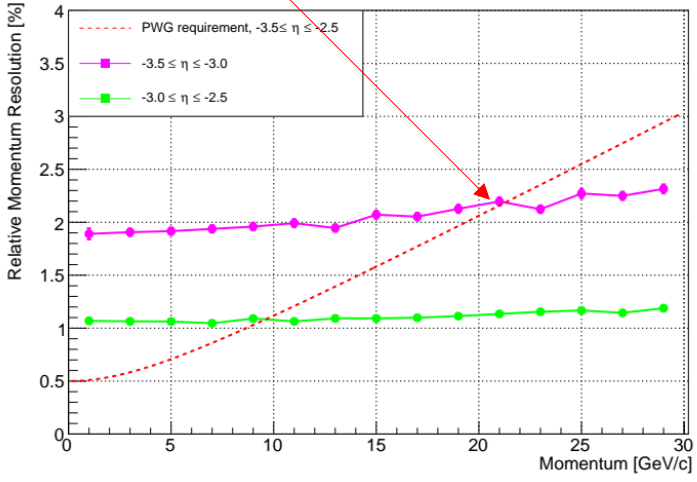
Number of generated electrons

Electron distributions (18x275GeV^2)

Pythia8 NC-DIS events, Q^2>1GeV^2
Files at ATHENA/RECO/canyonlands-v1.2/DIS/NC/energy/minQ2=1 on S3



- For 18x275GeV^2 beams, distributions peaked at 18GeV in momentum and ~-3.5 in η
- Requirements met in -3.5 < η < -3 for p > ~20GeV



Number of reconstructed electrons

Number of generated electrons

Summary

- Tracking performance plots show requirements are not met for momentum resolution in the backward region ($\eta < -2$)
- Pion distributions versus p and η show that pions are mostly generated at low momentum and in the forward region. Those generated in the backward region are mostly generated at $\eta > -2$ so tracking performance is sufficient
- Tracker performance also sufficient for scattered electrons at lower beam energies
- Tracker does not meet requirements for scattered electrons at higher beam energies → these electrons would likely be better measured by calorimeters

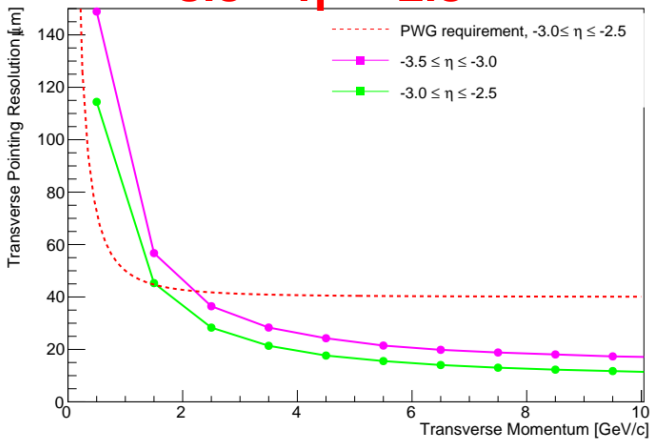
Next Steps

- NC-DIS is only one of the possible interactions → Look into charged particle distributions for other processes

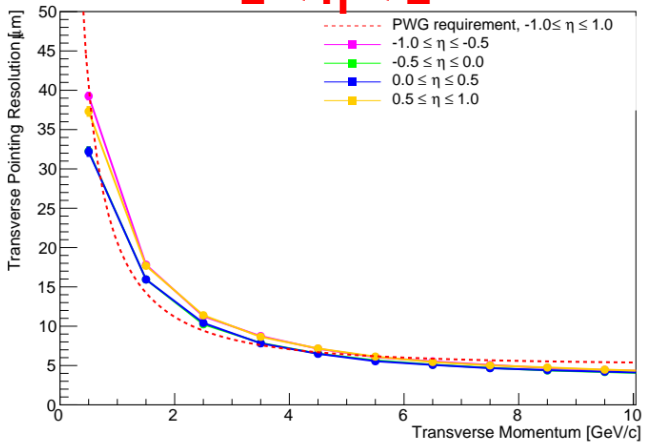
Backup Slides

Transverse Pointing Resolution (Baseline 2.0)

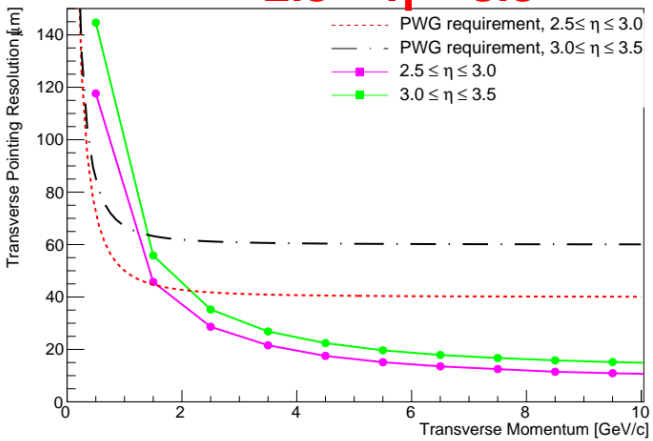
-3.5 < η < -2.5



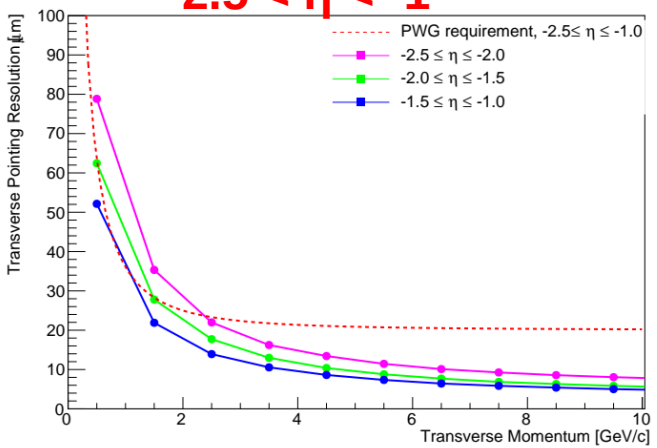
-1 < η < 1



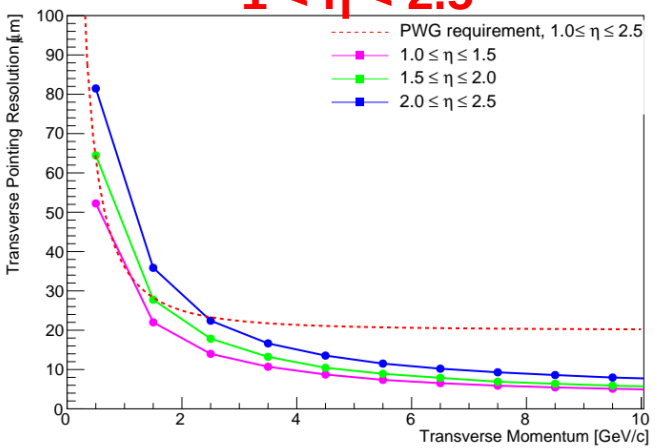
2.5 < η < 3.5



-2.5 < η < -1



1 < η < 2.5



Performance in line with supplementary material
→ Struggle to meet requirements at low p_T

Fun4All Setup

Silicon Disks

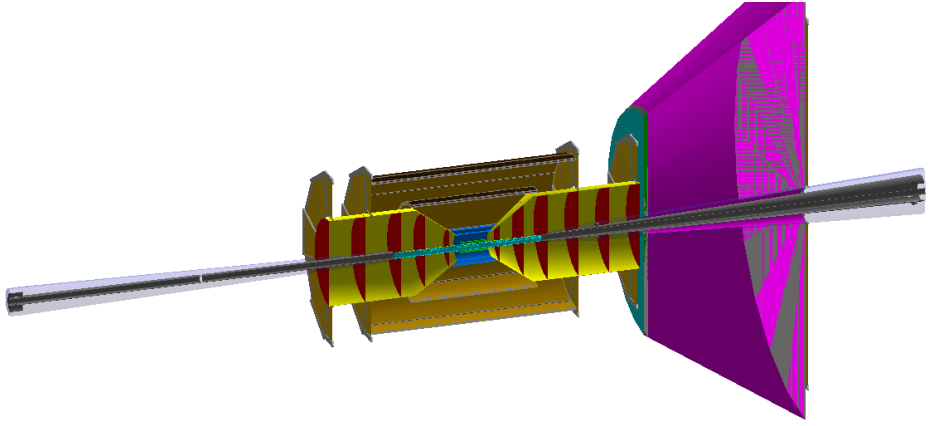
Inner R (cm)	Outer R (cm)	Z Position (cm)	Resolution	Active Area Material (X/X0 %)
3.18	18.62	-25.0	10 um pixel pitch	0.24
3.18	36.50	-49.0	10 um pixel pitch	0.24
3.18	43.23	-73.0	10 um pixel pitch	0.24
3.95	43.23	-109.0	10 um pixel pitch	0.24
5.26	43.23	-145.0	10 um pixel pitch	0.24

Silicon Disk Support Material

Material	Thickness (cm)	Geometry
Al	0.2	cone from (z [cm], rho [cm]) = (-16.8, 12.58) to (-58.42, 43.23) and cylinder from (-58.42, 43.23) to (-145, 43.23)

MPGD Trackers

Inner R (cm)	Outer R (cm)	Z Position (cm)	Resolution	Active Area Material (X/X0 %)
44.68	76.91	-103.0	250 um (r) x 50 um (r-phi)	0.4
44.68	76.91	-141.74	250 um (r) x 50 um (r-phi)	0.4



Silicon Tracker (3 Vertex + 2 Barrel Layers)

R (cm)	Length (cm)	Resolution	Active Area Material (X/X0 %)
3.3	28.0	10 um pixel pitch	0.05
4.35	28.0	10 um pixel pitch	0.05
5.4	28.0	10 um pixel pitch	0.05
13.34	34.34	10 um pixel pitch	0.55
17.96	46.68	10 um pixel pitch	0.55

Micromegas Barrel (4 barrel layers)

R (cm)	Length (cm)	Resolution	Active Area Material (X/X0 %)
47.72	127.47	150 um (r-phi) x 150 um (z)	0.4
49.57	127.47	150 um (r-phi) x 150 um (z)	0.4
75.61	201.98	150 um (r-phi) x 150 um (z)	0.4
77.46	201.98	150 um (r-phi) x 150 um (z)	0.4

Silicon Disks

Inner R (cm)	Outer R (cm)	Z Position (cm)	Resolution	Active Area Material (X/X0 %)
3.18	18.62	25.0	10 um pixel pitch	0.24
3.18	36.50	49.0	10 um pixel pitch	0.24
3.47	43.23	73.0	10 um pixel pitch	0.24
5.08	43.23	103.65	10 um pixel pitch	0.24
6.58	43.23	134.33	10 um pixel pitch	0.24
8.16	43.23	165.0	10 um pixel pitch	0.24

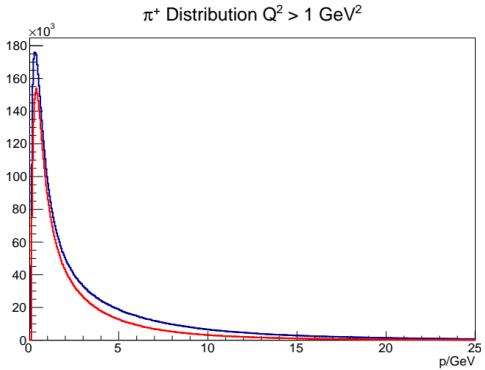
Silicon Disk Support Material

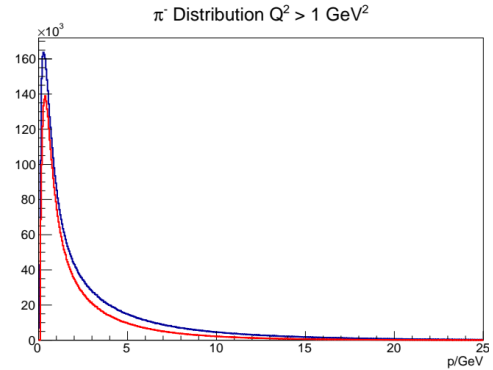
Material	Thickness (cm)	Geometry
Al	0.2	cone from (z [cm], rho [cm]) = (16.8, 12.58) to (58.42, 43.23) and cylinder from (58.42, 43.23) to (165, 43.23)

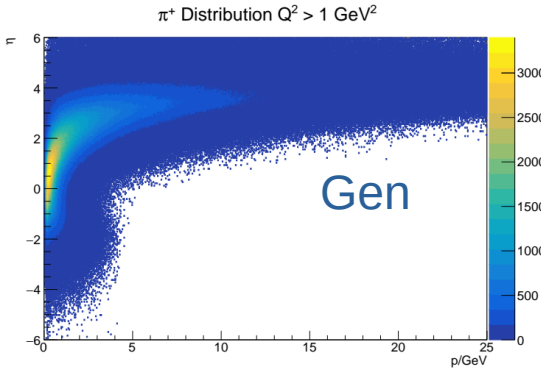
MPGD Trackers

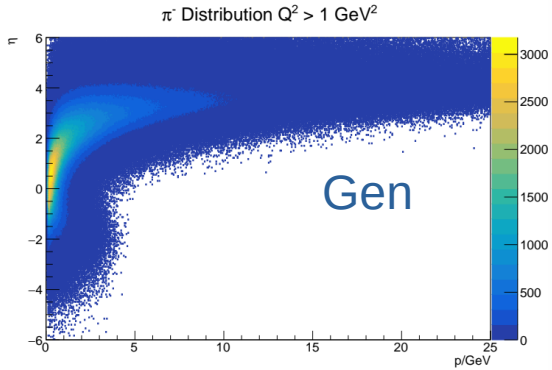
Inner R (cm)	Outer R (cm)	Z Position (cm)	Resolution	Active Area Material (X/X0 %)
44.68	76.91	105.76	250 um (r) x 50 um (r-phi)	0.4
44.68	76.91	161.74	250 um (r) x 50 um (r-phi)	0.4
19.34	195.5	332.0	250 um (r) x 50 um (r-phi)	0.4

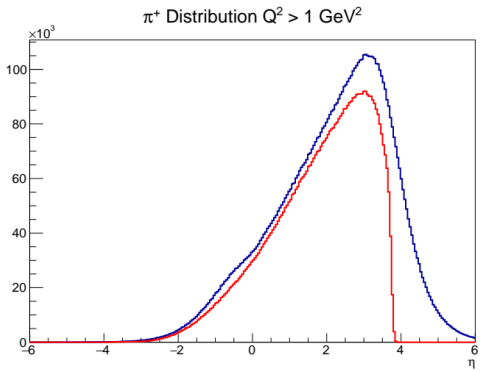
Pion distributions ($5x41GeV^2$)

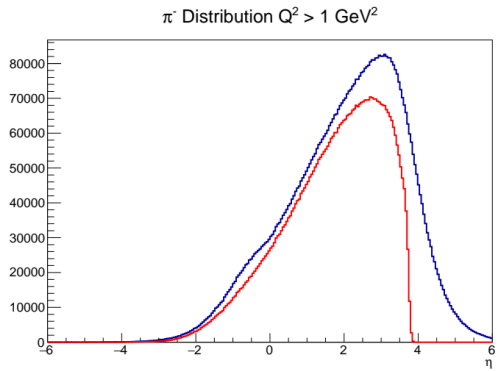


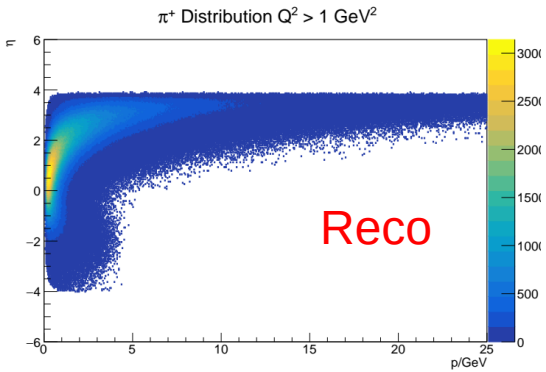


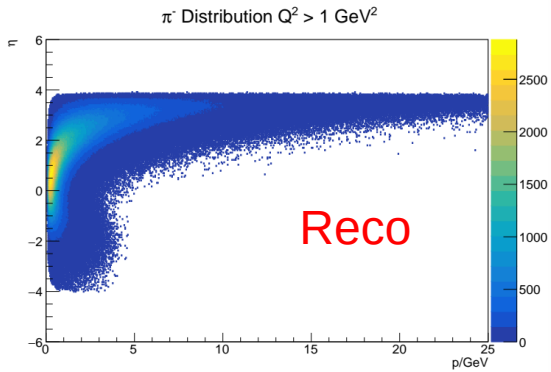








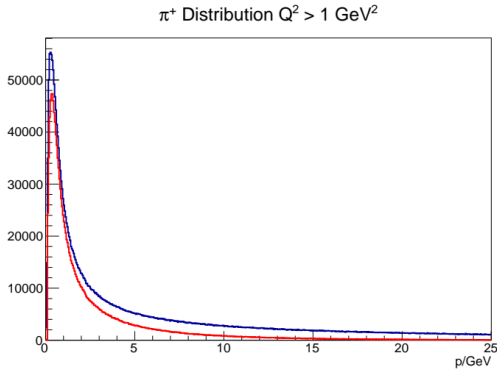


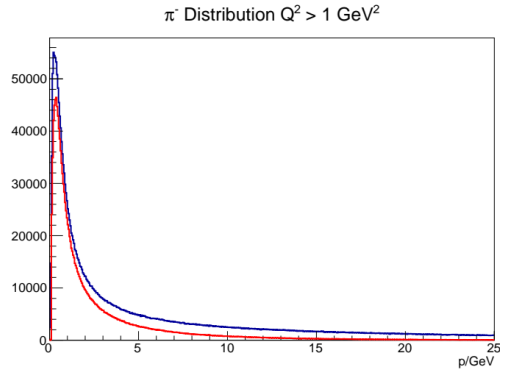


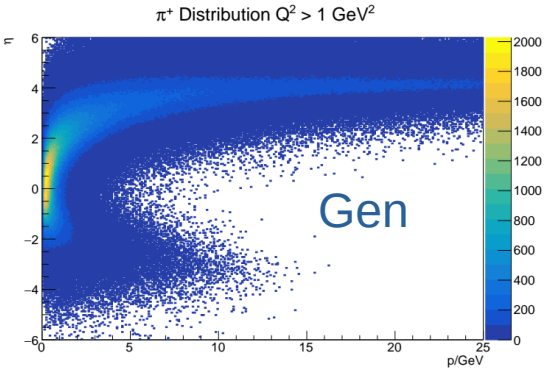
Number of reconstructed pions

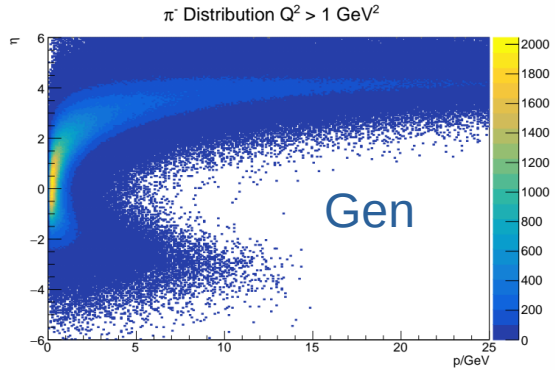
Number of generated pions

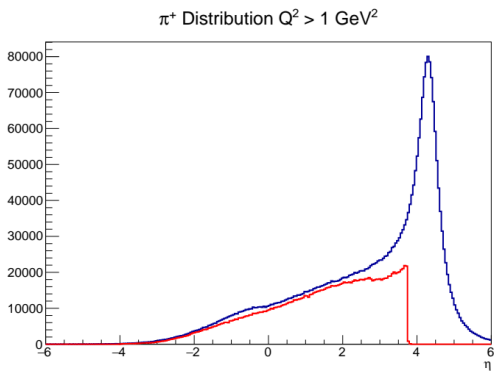
Pion distributions ($18x275GeV^2$)

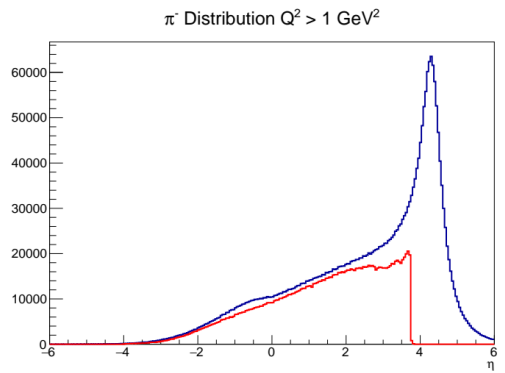


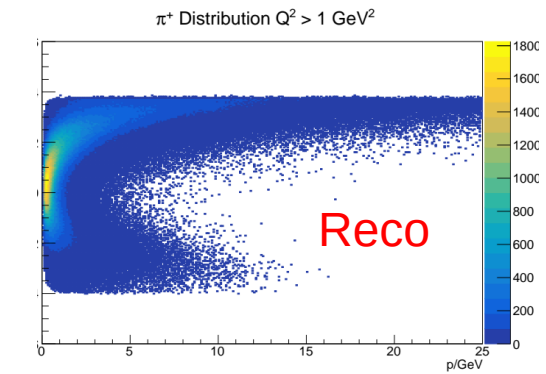


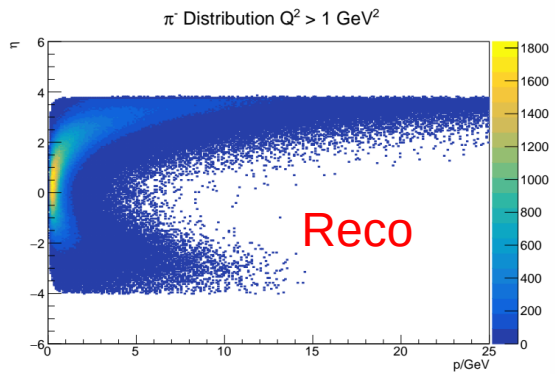






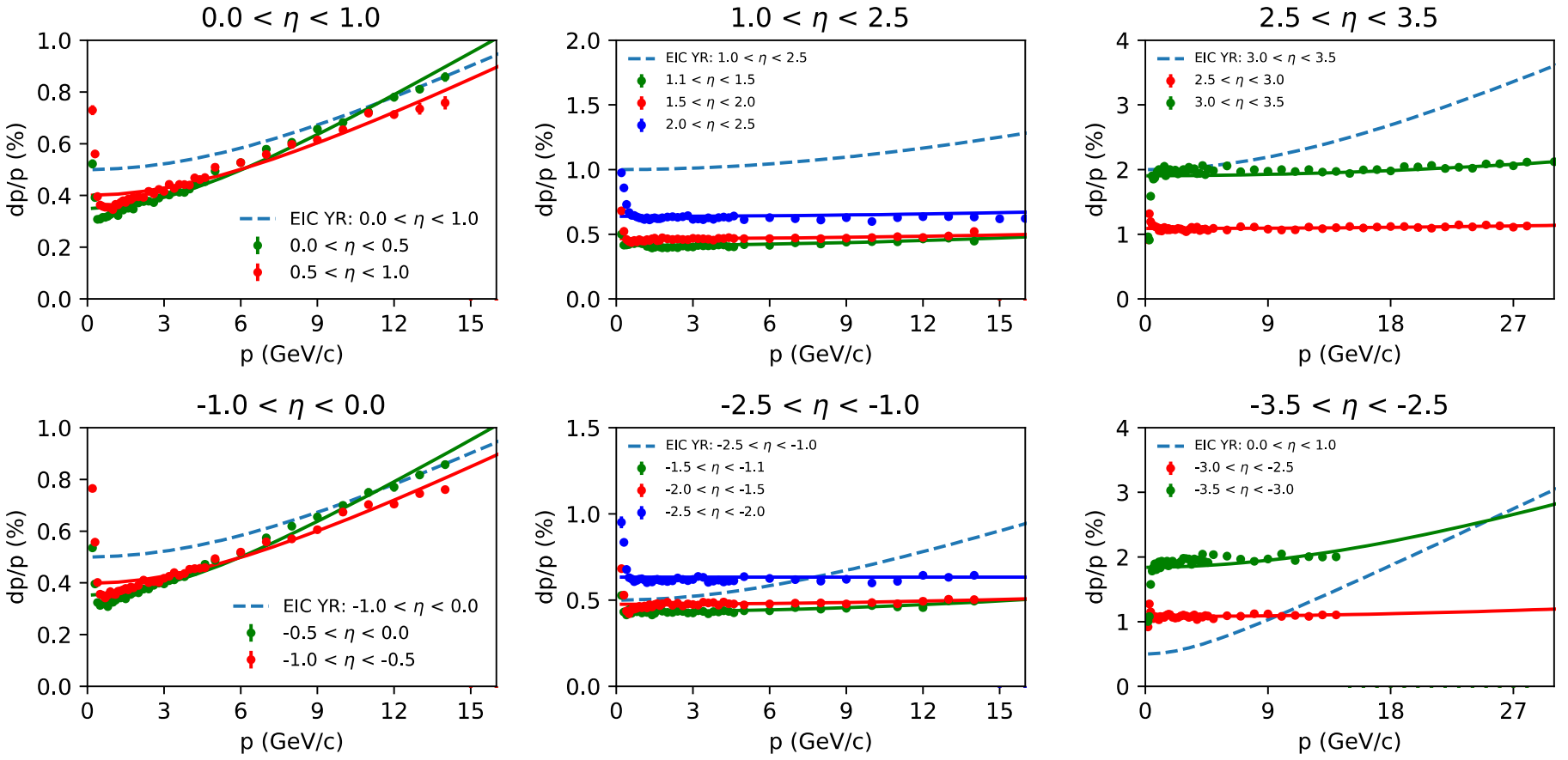


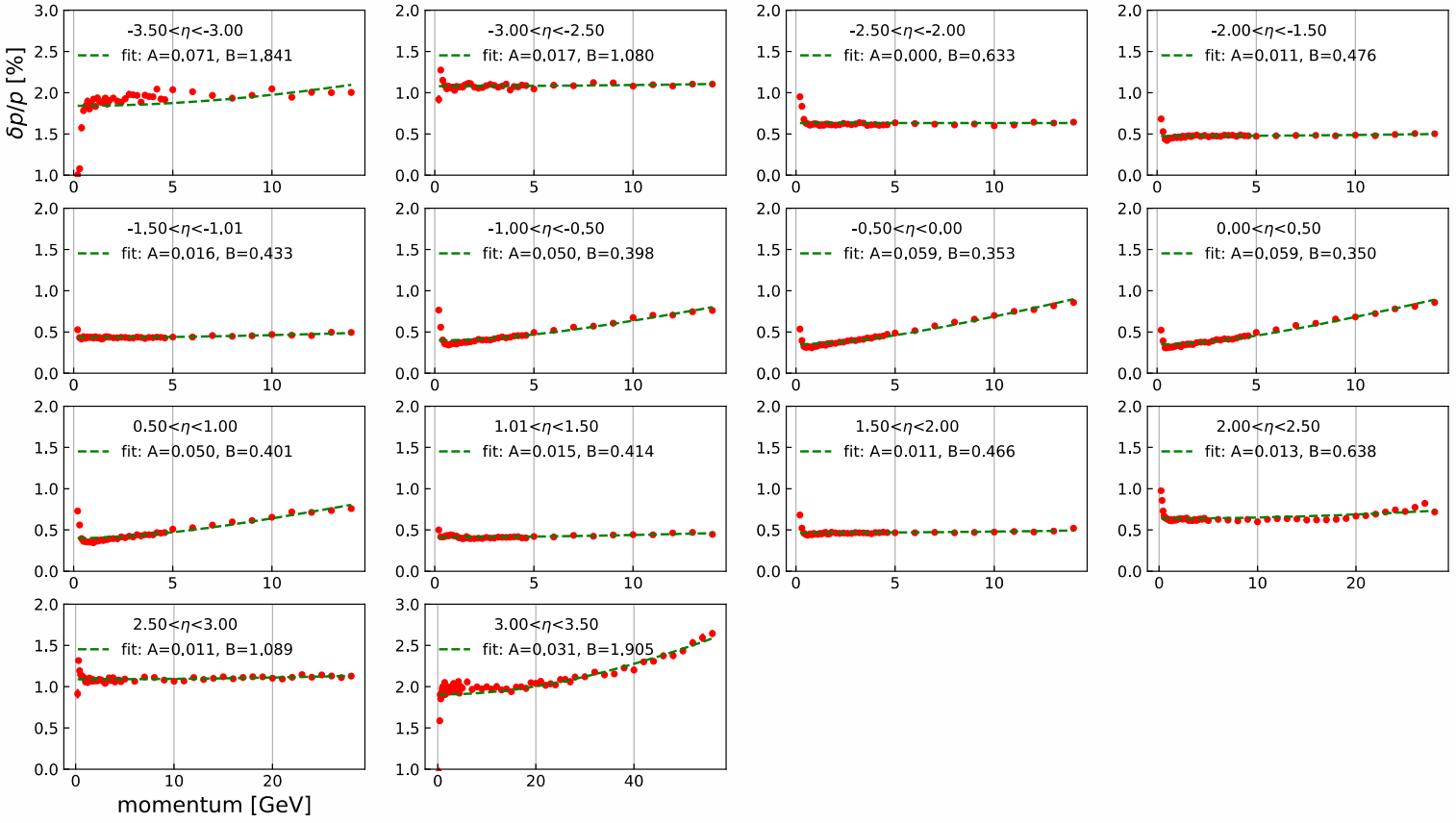




Number of reconstructed pions

Number of generated pions


0.0 < η < 1.0
EIC YR: 0.0 < η < 1.0
0.0 < η < 0.5
0.5 < η < 1.0
1.0 < η < 2.5
EIC YR: 1.0 < η < 2.5
1.1 < η < 1.5
1.5 < η < 2.0
2.0 < η < 2.5
2.5 < η < 3.5
EIC YR: 3.0 < η < 3.5
2.5 < η < 3.0
3.0 < η < 3.5
-1.0 < η < 0.0
EIC YR: -1.0 < η < 0.0
-0.5 < η < 0.0
-1.0 < η < -0.5
-2.5 < η < -1.0
EIC YR: -2.5 < η < -1.0
-1.5 < η < -1.1
-2.0 < η < -1.5
-2.5 < η < -2.0
-3.5 < η < -2.5
EIC YR: 0.0 < η < 1.0
-3.0 < η < -2.5
-3.5 < η < -3.0
dp/p (%)
p (GeV/c)


δp/p [%]
momentum [GeV]
-3.50<η<-3.00
fit: A=0.071, B=1.841
-3.00<η<-2.50
fit: A=0.017, B=1.080
-2.50<η<-2.00
fit: A=0.000, B=0.633
-2.00<η<-1.50
fit: A=0.011, B=0.476
-1.50<η<-1.01
fit: A=0.016, B=0.433
-1.00<η<-0.50
fit: A=0.050, B=0.398
-0.50<η<0.00
fit: A=0.059, B=0.353
0.00<η<0.50
fit: A=0.059, B=0.350
0.50<η<1.00
fit: A=0.050, B=0.401
1.01<η<1.50
fit: A=0.015, B=0.414
1.50<η<2.00
fit: A=0.011, B=0.466
2.00<η<2.50
fit: A=0.013, B=0.638
2.50<η<3.00
fit: A=0.011, B=1.089
3.00<η<3.50
fit: A=0.031, B=1.905